# A KEY TO THE MARINE ALGAE OF NEW SOUTH WALES.

## Part 1. CHLOROPHYCEAE.

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[Read 27th July, 1938.]

### *Introduction.*

The Marine Algae include very diverse forms, varying from unicellular, motile organisms to highly differentiated, attached thalli. Of these, this paper is concerned with attached, littoral marine forms only; these may be branched and bear leaf-like appendages.*

The geographic disposition of algae is affected greatly by light, and the influence of temperature is illustrated by the alterations in the flora due to warm or cool currents. The vegetation of any one locality is influenced by factors which affect the efficiency of the holdfast, as, for instance, the type of substrate (permanent—rock, or unstable—sand or mud), steepness of slope, degree of smoothness, and the extent of exposure to storms. Where the substrate is of sand or mud a further complication is introduced, in that 'silting up' occurs. Proximity to land influences the habitat through aeration and drainage. Some marine plants are never exposed between tides, while others are rarely, if ever, covered, receiving merely sea spray at high tides. The plants which occur above low-tide level, as compared with the completely submerged types, are subject to very much greater variation in such factors as temperature, salinity (which may be increased by evaporation from pools, or decreased by dilution with fresh water), aeration, hydrogen-ion concentration and light. The plants of the inter-tidal zone may be classified into those which are completely exposed, and those which occur in rock pools. The exposed forms are liable to suffer from excessive loss of water. With increasing depth of water the light intensity decreases logarithmically. This progressive change in habitat results in a vertical zoning of the plants. That the controlling factor in this zonation is light, not depth, is shown by the occurrence of a similar sequence of algal forms inwards from the mouth of a cave. Plants may affect each other by competition or indirectly, as, for instance, by an abundant crop of epiphytes causing too great a strain on the holdfast of the host-plant. Occasionally parasitism occurs. With plants possessed of varied degrees of adaptation to each of these interacting factors, there is possible a high degree of complexity in the structure of the community. To this must be added that in many cases the relative frequency of a plant varies seasonally, so that ecological work, to be by any means complete, should cover at least the year.

Variation in form is common among the algae; this may be due to seasonal changes (e.g. *Pylaiella littoralis*) or to differences of habitat. Variation due to habitat may affect intensity of colour (especially among the Red seaweeds), body

* For simplicity, in the key, these are referred to as 'leaves'.

shape (*Hormosira Banksii*), plant size* (*Enteromorpha intestinalis*), cell size* (*Ectocarpus confervoides*) and even the presence or absence of vesicles (*Blossevillea retroflexa*). It would seem necessary to examine a plant throughout at least one year and to collect it from different habitats in order to determine its range of variation.

Since autotrophic organisms, in the sea as on the land, are the source of energy for all others, it is important that something should be known of 'the pastures of the sea'. Formerly the planktonic section was considered more important in this connection. Now, however, the attached plants and accumulated detritus are recognized by many as at least comparable in importance. More work is needed to establish connected food chains of the sea. As Tilden (1935) says, 'it is time that the primary links of the food chain received due recognition'. It was an interest in animal-plant relationships which led to the preparation of this paper, 'for, after all, no satisfactory progress is possible until one can be sure of the species of the animal that devours and of the plant devoured' (Tilden, 1935). The food value of marine algae is now slightly recognized, and Occidentals are following the example of many Pacific Island dwellers and Orientals in including this in their diet. As yet the Japanese lead the way in the economic culture of seaweeds. Medicinally 'Irish Moss' has been used for many years. There is no seaweed known to be poisonous.

Further uses to which various algae have been put include the feeding of sheep and cattle, agar-agar manufacture, soil fertilizing, paper manufacture, and sodium, potassium, iodine and bromine extraction.

Systematic work on the Australian seaweeds was begun early in the nineteenth century. Lucas (1936) gives an outline of the progress of phycology in Australia. Harvey (1863) and Sonder (1880) each presented a list of Australian seaweeds and localities from which they had been recorded. In 1909–1912 Lucas published a list of the seaweeds then recorded from Australia, together with the letters E, W, N and S to show the distribution. There were 20 species of green seaweeds from the east coast (E). Since that time Lucas has published odd notes adding to the knowledge of distribution, but no further comprehensive list has appeared. The position then is that there exists no complete account of the algae found on the coast of New South Wales. The only keys available at all pertaining to Australian seaweeds are those of Lucas (1936) and Bastow (1898, 1899). The genera have been altered considerably since the publication of Bastow's work. Accordingly an essential prelude to algology in New South Wales is a list of the species recorded from the State and a simple mode of distinguishing them. The present series aims at supplying this information and also at bringing the terminology and classification as up-to-date as possible. In this paper the green seaweeds only are presented; it is hoped to publish further contributions in other groups later.

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* It appears to the writer that the customary method of using cell and/or plant size for specific determinations is unsatisfactory. In the literature there abound conflicting reports of the size limits of a species. As an example, Setchell and Gardner (1925) and Newton (1931) report differently as to the size of the plant of *Ectocarpus confervoides* (Roth.) Le Jol.; their reports differ also as to the limits to size in vegetative cells and reproductive units in *E. terminalis* Kuetz. The writer took a series of measurements of the cell lengths in branches of a single plant of *E. confervoides* (Roth.) Le Jol. The mean was 0·0651 mm., and $\sigma$ was 0·0208 mm. It follows that in this instance there must be a difference of at least 37% in cell size before the length of the cells becomes significant as a means for separating species.

In order to learn what species had been recorded from New South Wales, the algal herbaria at the National Herbarium, Sydney, the Council for Scientific and Industrial Research, Canberra, and the University of Sydney, were examined. The localities given for those plants which were definitely named were noted and are quoted in the body of this paper. Professor Lucas had been an Honorary Custodian of the algae at the National Herbarium for many years, and the collections at the C.S. and I.R., Canberra, and at Sydney University, were named by him, so it would seem that all the plants examined may be considered as named or accepted by him. Besides the localities mentioned on herbarium material, additional localities were sought in all available literature.

The occurrence of New South Wales plants at Lord Howe Island or Norfolk Island has been noted for comparison; similarly any occurrence in the adjoining States of Victoria and Queensland was included when herbarium material recorded those localities, but all literature was not consulted, because it is impossible to complete the series without consulting the Queensland and Victorian herbaria also.

There are now 34 species of green seaweeds recorded from New South Wales (cf. 20 'E' in 1912). Further study will add, almost certainly, to this number.

In addition to the making of a list of those species recorded from the coast of New South Wales, and of their distribution, as far as known, an attempt has been made to construct a natural key. Where any large group which is known to include marine forms is not represented from the territory under discussion a note has been made regarding it in the key.

Under each species name are listed, at the end of the paper, those synonyms attributed to it by various workers. In each case reference is given to an authority for the acceptance of the synonymy. Following this is an alphabetical list of the synonyms which allows quick reference to the key.

The abbreviations used below as sub-headings under localities are as follows:
C.S. & I.R.: Lucas Collection, Council for Scientific and Industrial Research, Canberra.
D.T.: De Toni, G. B. (1889).
Harv. Aus.: Harvey, W. H. (1858-63).
Herb. Notes: Notes or lists of collections found at the National Herbarium, Sydney.
Laing: Laing, R. M. (1900).
Muell.: Sonder, W. (1880).
Nat. Herb.: The algal section, National Herbarium, Sydney.
Okamura: Okamura, K. (1904).
Sonder: Sonder, W. (1871).
University: The algal herbarium, University of Sydney.

I wish to express thanks to Assistant-Professor J. McLuckie, Botany School, University of Sydney, to the authorities of the National Herbarium, Sydney, and of the Division of Plant Industry, C.S. & I.R., Canberra; without the facilities made available by them this work would not have been possible. I have pleasure also in thanking Mr. R. H. Anderson, Government Botanist and Curator, National Herbarium, and Professor Eric Ashby for their help and criticism during the preparation of this paper.

The classification used in the present key is as follows:

CHLOROPHYCEAE.

Protococcales.
Ulotrichales.
Schizogoniales.
Ulvales: Ulvaceae (1. *Enteromorpha*; 2. *Ulva*).

Siphonales: Protosiphonaceae; Bryopsidaceae (3. *Bryopsis*); Derbesiaceae; Vaucheriaceae (4. *Vaucheria*); Codiaceae (5. *Codium*); Caulerpaceae (6. *Caulerpa*).

Siphonocladiales: Dasycladiaceae (7. *Acetabularia*); Valoniaceae (8. *Microdictyon*); Cladophoraceae (9. *Chaetomorpha*; 10. *Rhizoclonium*; 11. *Cladophora*).

### Chlorophyceae Kuetz.

i. Plant uni- or multi-cellular; normal cells uninucleate, although attachment rhizoids may be coenocytic. This includes Protococcales (Meneghini) Oltmanns: Cells solitary or in non-filamentous colonies; Ulotrichales Blackman and Tansley: Thallus filamentous and chromatophores parietal; Schizogoniales West: Thallus simple, filamentous and chromatophores axile.
Thallus membranaceous; chromatophore parietal; pyrenoid(s) present; frond of one or two layers of cells; cylindrical form sometimes assumed ..... Order Ulvales Blackman and Tansley.

ii. Plant uni- or multi-cellular, coenocytic.
Plant a single coenocyte which may produce a complex individual; transverse walls occur only in connection with reproduction, or as secondary septa-'plugs'; chloroplasts lens- or disc-shaped and numerous; cytoplasm lines the wall and there is a continuous, sap-containing cell cavity .. Order Siphonales (Grev.) Oltmanns.
Plant a series of coenocytes; chromatophores usually numerous, small, disc-shaped, each with one pyrenoid, or large, single, parietal, reticulate, with many pyrenoids ..... Order Siphonocladiales (Blackman and Tansley) Oltmanns.

### Order Ulvales Blackman and Tansley.

Only family ..... Ulvaceae Grev.
Frond tubular even at maturity ..... 1. *Enteromorpha* Link.
In mature frond there are two continuous layers of cells united wholly or in part; frond broad, expanded ..... 2. *Ulva* Linn.

### Order Siphonales (Grev.) Oltmanns.

New South Wales possesses no members of the Protosiphonaceae Blackman and Tansley; this family is unique for this order in that the thallus is not filamentous.

Filaments free.
Fronds pinnately branched ..... Bryopsidaceae (Bory.) D.T.
Chromatophores numerous, disc-shaped and each with one pyrenoid. Only genus recorded from N.S.W. ..... 3. *Bryopsis* Lamour.
Fronds irregularly or dichotomously branched. This includes Derbesiaceae (Thur.) Kjellm. Anisogamous; zoospores single, with many cilia .... Vaucheriaceae Dumort.
Filaments continuous, without constriction. Only genus recorded from N.S.W. .... ..... 4. *Vaucheria* DC.

Thallus complex, filaments being interwoven, or strengthened by trabeculae.
Thallus composed of intertwined, branching filaments; peripheral branchlets forming a palisade or pavement-like, external layer ..... Codiaceae (Trev.) Zan.
Thallus spongy, not jointed nor calcified. Only genus recorded from N.S.W. ..... ..... 5. *Codium* Stackh.
Thallus consists of a creeping, rhizome-like axis—absent in *C. ambigua* Okamura—bearing branched rhizoids or holdfasts on its underside and foliar shoots from the upper; trabeculae, which traverse the lumen of the coenocyte from wall to wall, brace the system internally ..... Caulerpaceae Reichenbach.
Only genus ..... 6. *Caulerpa* Lamour.

### Order Siphonocladiales (Blackman and Tansley) Oltmanns.

Thallus consists of a much elongated, cylindrical, axial segment, bearing at its apical portion numerous, acropetal whorls of branches ..... Dasycladiaceae (Endl.) Cramer.
Sporophyte erect, calcareous and terminated above by a disc, or series of superimposed discs, of laterally-coherent branch coenocytes arranged in a whorl; these bear projections forming rings—'coronae'—on one or both faces near the apex.
Only genus recorded from N.S.W. ..... 7. *Acetabularia* Lamour.

Frond of simple or branching, monosiphonous filaments, free or more or less united laterally; all axes of indefinite growth.
Segregative division occurs, i.e., membranes are formed around central or peripheral accumulations of protoplasm and chloroplasts and thus more or less numerous, small cells are formed ..... Valoniaceae Oltmanns.

Branched filaments anastomose, forming a network in one plane, the whole resembling the softened skeleton of a dicotyledonous leaf; cells uniform and cylindrical; lobed chromatophores usually arranged to form a network. Only genus recorded from N.S.W. ..... 8. *Microdictyon* Decne.*

Cell division not segregative; cell network not formed; walls usually thick and clearly stratified ..... Cladophoraceae (Hass.) D.T.

Filaments simple, or very nearly so.

Filaments usually stiff or rigid; rhizoidal branchlets absent; slight constrictions usually occur between the cells ..... 9. *Chaetomorpha* Kuetz.

Filaments flaccid, unattached and prostrate; rhizoidal branchlets occur; filaments not constricted as in *Chaetomorpha* ..... 10. *Rhizoclonium* Kuetz.

Filaments branched, but not held together by special branchlets ..... 11. *Cladophora* Kuetz.

### Genus 1. Enteromorpha Link.

Cells not arranged in longitudinal series except perhaps in the youngest parts.

Thallus simple or with few branches; usually inflated and constricted and often of a large size ..... 1. *E. intestinalis* (Linn.) Link.

*Locality.*—C.S. & I.R.: Botany Bay, Bondi, Port Jackson. Sonder: (also Queensland).

Thallus produces more or less numerous branches.

Branches attenuate at the base and apex ..... 2. *E. lingulata* J. Ag.

*Locality.*—Nat. Herb.: Bondi (also Victoria).

Branches attenuate at the base only ..... 3. *E. compressa* (Linn.) Grev.

*Locality.*—Nat. Herb.: Cook's River, Coogee (not labelled), (also Queensland). C.S. & I.R.: Port Jackson. Harv. Aus.: 'All parts of coast and estuaries.'

Cells arranged in a longitudinal series in the greater part of the frond; thallus regularly and proliferously branched; branches similar to the main filaments ..... 4. *E. prolifera* (Muell.) J. Ag.

*Locality.*—Nat. Herb.: Botany Bay, Port Jackson.

### Genus 2. Ulva Linn.

Frond lanceolate with a tubular stipe ..... 5. *U. Linza* Linn.†

*Locality.*—Nat. Herb.: Plant as *Enteromorpha Linza* (Linn.) J. Ag., Port Jackson.

Frond variously shaped; stipe, when present, solid; thallus often deeply split.

Frond of long, twisted ribbons, the margins of which are abundantly and closely undulate; the two layers of cells easily separable in the upper parts ..... 6. *U. laetivirens* Aresch.

*Locality.*—Nat. Herb.: Port Jackson. C.S. & I.R.: (also Victoria).

Frond of variable outline, ovate to lanceolate, more or less folded; margin usually quite entire; shortly stipitate or nearly sessile ..... 7. *U. lactuca* Linn.

*Locality.*—Nat. Herb.: Botany Bay (also Victoria and Lord Howe Is.). Sonder: Richmond River. Harv. Aus.: 'Australian coasts.' Okamura: Plant as *U. rigida* Ag., Sydney.

### Genus 3. Bryopsis Lamour.

Ramuli distinctly spreading, arising, usually alternately, at rather long intervals except at the tips of the branches; they are very long, constricted at the base, but do not taper to the blunt apex ..... 8. *B. baculifera* J. Ag.

*Locality.*—Lucas (1913): Parramatta River (also Victoria).

Ultimate ramuli form plumes with distichous, slender, pinnules, gradually narrowed above and to the base ..... 9. *B. plumosa* (Huds.) Ag.

*Locality.*—Nat. Herb.: Parramatta River (also Victoria and Queensland). C.S. & I.R.: (also Lord Howe Island). Harv. Aus.: 'Coasts of Australia.'

### Genus 4. Vaucheria DC.

Male and female reproductive organs occur on separate filaments; antheridia egg-shaped or ellipsoidal and sessile; oogonia spherical or slightly elongated and with a terminal ostiole; sperm liberation by a definite, apical aperture .... 10. *V. dichotoma* (Linn.) Ag.

*Locality.*—Nat. Herb.: Stanwell Park (tidal).

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* Proof of segregative division is not completed as yet; the classification of this genus, therefore, may later be changed.

† Authorities differ as to whether this plant should be called *Ulva Linza* Linn. or *Enteromorpha Linza* (Linn.) J. Ag., as it is intermediate between the two genera.

Genus 5. Codium Stackh.

Thallus prostrate and unbranched.

Thallus forms a broad, green, sponge-like, felted, encrusting layer; utricle hairs present ..... 11. *C. adhaerens* (Cabr.) Ag.

*Locality.*—Harv. Aus.: Port Jackson. Herb. Notes: (also Queensland).

Thallus cushion-shaped and lobed.

Thallus dark green ..... 12. *C. Lucasii* Setchell.

*Locality.*—C.S. & I.R.: Eden, Maroubra, Bondi, Long Reef (also Victoria and Lord Howe Island). Lucas (1935): Newcastle.

Thallus light green ..... 13. *C. spongiosum* Harv.

*Locality.*—Nat. Herb.: Port Jackson, Lake Macquarie (also Queensland). C.S. & I.R.: (also Lord Howe Island).

Thallus erect; fronds dichotomous.

Fronds flattened, especially beneath forkings.

Utricles 0·4 mm. or more in diameter, never mucronate ..... 14. *C. decorticatum* (Woodw.) Howe.

*Locality.*—Nat. Herb.: Botany Bay. C.S. & I.R.: Port Jackson (also Victoria). Lucas (1936): (also Lord Howe Island). Herb. Notes: (also Queensland).

Utricles up to 0·4 mm. in diameter and bearing short hairs near their outer ends ..... 14*a*. *C. cuneatum* S. & G.

*Locality.*—Lucas (1935): Botany Bay, Port Jackson. C.S. & I.R.: (also Queensland and Lord Howe Island).

Fronds cylindrical, terete.

Utricles flattened or rounded, vesiculose, the membrane not much thickened ..... 15. *C. Muelleri* Kuetz.*

*Locality.*—Nat. Herb.: Eden, Jervis Bay (cast up), Maroubra, Botany Bay (also Victoria and Queensland). C.S. & I.R.: Port Jackson, Collaroy, Lake Macquarie. Sonder: Ballina, Richmond River. Lucas (1936): 'Round Australia and Tasmania.' Laing (also Norfolk Island). Herb. Notes: Clarence River.

Utricles end in a sharp or blunt point (mucro), most obvious where there is young growth ..... 16. *C. fragile* (Suring.) Heriot.

*Locality.*—Nat. Herb.: Eden, Long Bay, Port Jackson (also Victoria); plant as *C. mucronatum* J. Ag., Brisbane Waters; Port Macquarie, Bermagui River. C.S. & I.R.: Botany Bay, Bondi, Collaroy. Herb. Notes: Lake Macquarie, Manning River.

Genus 6. Caulerpa Lamour.

Stolons covered with scales; fronds cylindrical; branching distichous, sub-opposite or alternate; ramenta simple or bifid, mucronate ..... This is the sub-genus *Araucarioideae* J. Ag.

Frond feather-like in shape; ramenta of trunk and branches shortly subulate with bi-mucronate tips, arranged in pairs, which are sometimes united and so appear as a single, forked structure ..... 17. *C. hypnoides* (R. Br.) Ag.

*Locality.*—Nat. Herb.: Eden, Sydney district (also Victoria). Lucas (1936): 'Anywhere on Australian and Tasmanian coasts.'

Some workers divide this species further as:

Ramenta pairs united for some distance above the base ..... *C. Muelleri* Sond.

Ramenta pairs united only at base; colour darker, growth more robust, ramenta more erect, scales of stolons less densely set and less finely divided than, in the above species ..... *C. hypnoides* (R. Br.) Ag.

Stolons bare.

Fronds flat, deeply dentate, pinnulate or pinnate, rarely cylindrical and then surrounded by filiform pinnules reaching up to four times the diameter of the central axis ..... This is the sub-genus *Filicoideae* J. Ag.

Frond large, plane, lanceolate-linear, simple or branched, pinnate or lobed; pinnules of lobes usually alternate, sometimes sub-opposite; tips attenuated and entire or toothed and rounded ..... 18. *C. scalpelliformis* (R. Br.) Ag.

*Locality.*—Nat. Herb.: Jervis Bay (cast up) (also Victoria).

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* Lucas (1936) calls this 'the Indo-Pacific representative of the more specially Atlantic species, *C. tomentosum* (Huds.) Stackh.'. Probably Sonder (1880) is referring to this species when recording *C. tomentosum* Ag. as occurring on the 'Coasts of Australia and Tasmania',

Fronds not deeply dentate, pinnulate nor pinnate.
Fronds bear distichous, alternate or multiseriate ramuli which are ovoid in shape, cylindrical or linear and sessile or pedicellate; fronds simple or branched, articulate or not ..... This is the sub-genus *Sedoideae* J. Ag.
Central axis not, or slightly, articulate: ramuli sessile, spherical or obovate, distichous and usually absent from parts of the rachis..19. *C. sedoides* (R. Br.) Ag.
*Locality.*—Nat. Herb.: Newcastle (also Victoria). C.S. & I.R.: (also Queensland). Harv. Aus.: Kiama. Lucas (1936): 'All round coasts of Australia, and Tasmania.'
Central axis annularly constricted; ramuli distichous.
Central axis bears at each articulation two opposite, linear ramuli, which are seven times longer than broad ..... 20. *C. articulata* Harv.
*Locality.*—Lucas (1931): Plant as *C. Hodkinsonia* J. Ag., Richmond River.
Base of central axis bare of ramuli; ramuli opposite, usually obovate, always articulate ..... 21. *C. cactoides* (Turn.) Ag.
*Locality.*—Nat. Herb.: Eden (also Victoria). Lucas (1931): Richmond River.
Fronds simple, entire or slightly divided.
Fronds plane, entire or finely dentate, often giving rise, by proliferation, to secondary fronds from the lamina of the preceding leaf ..... This is the sub-genus *Phyllanthoideae* J. Ag.
Frond linear, obtuse at the tip, pedicellate at the base, not annulate; proliferations rare ..... 22. *C. parvifolia* Harv.
*Locality.*—Nat. Herb.: Kiama, Port Jackson, Port Stephens.
Frond elongated, plane or cylindrical, simple or dichotomous, rarely with proliferations ..... This is the sub-genus *Zosteroideae* J. Ag.
Base of frond annulate ..... 23. *C. flagelliformis* Ag.
*Locality.*—C.S. & I.R.: Plant as *C. ligulata* Harv., Botany Bay. University: Plant as *C. ligulata* Harv., Balmoral.

### Genus 7. Acetabularia Lamour.

Inferior corona absent; superior composed of free knobs bearing hair tufts ..... 24. *A. peniculus* R. Br.
*Locality.*—Nat. Herb.: Plant as *Polyphysa peniculus* (R. Br.) Ag.,* Newcastle (also Victoria).
Inferior and superior corona present, both consisting of free processes, not united laterally to each other.
Sporangial rays with apiculate margins ..... 25. *A. crenulata* Lamour.
*Locality.*—Muell.: Richmond River (also Queensland).
Sporangial rays blunt, more or less scalloped at the margin, apiculum absent ..... 26. *A. calyculus* Quoy & Gaim.
*Locality.*—Nat. Herb.: Lake Macquarie, Newcastle (also Queensland). Lucas (1935): (also Lord Howe Island).

### Genus 8. Microdictyon Decne.†

Colour pale green; branching opposite the rule ..... 27. *M. Agardhianum* Decne.
*Locality.*—Harv. Aus.: Port Jackson.
Colour very dark green; size large; habit irregular; branching alternate or opposite to some extent, but at intervals in the primary filaments in fours and fives from the same point ..... 28. *M. umbilicatum* (Velley) Zan.
*Locality.*—Nat. Herb.: Botany Bay, Port Stephens. C.S. & I.R.: Port Jackson.

### Genus 9. Chaetomorpha Kuetz.

Filaments solitary or in tufts; plant attenuate at base; cells 0·15-0·50 mm. long and 1-2 times as long as broad; cylindrical filament slightly constricted between cells ..... 29. *C. aerea* (Dillw.) Kuetz.
*Locality.*—C.S. & I.R.: Bondi, Port Jackson, Curl Curl (also Queensland and Lord Howe Island). Harv. Aus.: (also Victoria). Laing: (also Norfolk Island).

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* Sub-genus *Polyphysa* has been accorded the rank of genus by some workers; good reason for not doing so is given by Solms-Laubach (1895).

† Prior to Setchell (1929) there existed much confusion in this genus, so that past specific determinations are now liable to be questioned.

Genus 10. Rhizoclonium Kuetz.

Cells 1½-2½ times as long as broad; rhizoidal branches none or few, short, non-septate, and usually continuous with the cells from which they rise ..... 30. *R. implexum* Batt.*

*Locality.*—C.S. & I.R.: Plant as *R. tortuosum* Kuetz., Botany Bay, Port Jackson.

Genus 11. Cladophora Kuetz.†

Plants forming thickened, cushion-like or rounded tufts ..... This is the sub-genus *Aegagropila* Kuetz.‡

Plants not united into spongy masses by rhizoidal or recurved branches; all branches similar, not increasing in size upwards; terminal cells short; adult cells not sub-dividing ..... This is the sub-genus *Eucladophora* Farlow.

Filaments attached throughout active life; fronds densely tufted, much branched, rigid; colour dark green; branches opposite or in fours, erect; ultimate ramuli short, blunt or slightly subulate; articulations at least three times as long as broad ..... 31. *C. rupestris* (Linn.) Kuetz.§

*Locality.*—C.S. & I.R.: Plant as *C. nuda* Harv., Botany Bay.

Fronds attached in irregular tufts when young, soon detached, floating.

Colour dull green; filaments somewhat irregularly, usually dichotomously, divided; branching often secund; ramuli blunt; cells 3-6 times as long as broad; dissepiments finally much contracted ..... 32. *C. fracta* (Dillw.) Kuetz.

*Locality.*—C.S. & I.R.: Stanwell Park.

Colour usually dark green; branching very rare; filaments 0·1-0·22 mm. wide; habit very near to *C. fracta* ..... 33. *C. chartacea* Grun.

*Locality.*—D.T.: Narrabeen Lagoon, near Port Jackson.

## Synonyms.

Under the name of each accepted species are listed those synonyms which various workers have attributed to it. In each case a bracketed number then follows. This number indicates the authority quoted for the acceptance of the synonymy. The numbers and their corresponding references are:

(1) De Toni, 1889; (2) Harvey, 1858-1863; (3) Harvey, 1846-1851; (4) Lucas, 1912; (5) Solms-Laubach, 1895; (6) Setchell, 1929; (7) Weber Van Bosse, 1898; (8) Laing, 1927; (9) Lucas, 1936; (10) Newton, 1931; (11) Setchell and Gardner, 1920; (12) Sonder, 1871.

1. Enteromorpha intestinalis (Linn.) Link.

*Enteromorpha africana* Kuetz. (12)
*lacustris* Hassall (1)
*minima* Kuetz. (12)
*spermatoidea* Kuetz. (1)
*Ulva Enteromorpha* var. *intestinalis* Le Jol. (1)
*intestinalis* Linn. (1), (3), (11), (12)
*Scytosiphon intestinalis* Lyngb. (1), (3)
*Fistularia intestinalis* Grev. (1), (3)
*Conferva intestinalis* Roth. (1), (3)
'*Solenia Bertolini* Ag. (3)
*intestinalis* Ag. (3)
*Ilea intestinalis* Gaill. (3)
*Tetraspora intestinalis* Desv. (3)

Varieties include:
*Ulva Enteromorpha* var. *compressa* f. *Cornucopiae* Le Jol. (1)
*Scytosiphon intestinalis* var. *Cornucopiae* Lyngb. (1)

2. Enteromorpha lingulata J. Ag.

*Enteromorpha compressa* var. *lingulata* (J. Ag.) Hauck. (1)
*crinita* Kuetz. ? nec *alior* (1)
*Ulva capillaris* Lamour. ? (1)
*compressa* Ag. ex parte (1)

3. Enteromorpha compressa (Linn.) Grev.

*Enteromorpha acanthophora* Kuetz.'(12)
*complanata* Kuetz. (1), (12)
*compressa* Link. (2), (4)
*fascia* Postels & Ruprecht (11)

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* Apparently this plant is extremely variable as Newton (England) says, 'filaments flaccid or lubricous . . . yellowish or light green', and Setchell and Gardner (America) say, 'filaments rigid . . . dark green'.

† Sonder (1880) lists *C. Woollsii* Sond. as from Parramatta River. This species is not mentioned by De Toni (1889).

‡ In the Lucas Collection, C.S. & I.R., Canberra, is a plant labelled *Cladophora* (*Aegagropila*) *annectens* Lucas. No description has been found and it is thought Professor Lucas had intended publishing a new species description. The locality given was Manly.

§ Newton (1931) includes *C. nuda* Harv. as a variety of *C. rupestris* (Linn.) Kuetz.

' De Toni regards this as a synonym of *Ulva Linza* Linn. This authority has been followed.

*Enteromorpha fulvescens* Kuetz. (12)
*Novae-Hollandiae* Kuetz. (12)
*paradoxa* Kuetz. (12)
*prolifera* S. & G. (part) (11)
*ramulosa* Kuetz. (12)
*spinescens* Kuetz. (12)
*Ulva compressa* Linn. (1), (3), (11)
*Enteromorpha* var. *compressa* Le Jol. (1)
*Scytosiphon compressus* Lyngb. A partim (1). (3)
*Conferva compressa* Roth. excl. var. (1), (3)
*Ilea compressa* Gaill. (1), (3)
*Solenia compressa* Ag. (3)
*Fistularia compressa* Grev. (3)
Varieties include:
*Enteromorpha compressa* Aresch. (1)
*Enteromorpha compressa* Crouan (1)

4. Enteromorpha prolifera (Muell.) J. Ag.

*Enteromorpha compressa* var. *prolifera* Grev. (1)
*intestinalis* f. *prolifera* Hauck. (1)
*pilifera* Kuetz. (1)
*tubulosa* var. *pilifera* Ahln. (1)
*Ulva compressa* var. *prolifera* Ag. (1)
*crinita* Mert. non Roth. (1)
*prolifera* Muell. (1), (11)
*Scytosiphon compressus* var. *crispatus* Lyngb. (1)

5. Ulva Linza Linn.

*Ulva Bertolonii* Ag. (1)
*crispata* Bertol. (1)
*Enteromorpha* var. *lanceolata* Le Jol. (1)
*Lactuca* forma *genuina* Tilden (not of Hauck.) (11)
*Enteromorpha Bertolonii* Mont. (1)
*Linza* (Linn.) J. Ag. (1)
*Solenia Bertolonii* Ag. (1)
*Linza* Ag. (1), (3)
*Phycoseris crispata* Kuetz. (1)
*lanceolata* Kuetz. (1)
**Linza* Kuetz. (3)
*olivacea* Kuetz. (1)
*planifolia* Kuetz. (1)
*smaragdina* Kuetz. (1)
*Ilea Bertolonii* De-Not. (1)
*Tremella marina fasciata* Dillw. (3)

7. Ulva Lactuca Linn.

*Ulva rigida* Ag. (4)
Varieties include:
*Ulva Australis* Kuetz. (1)
*fimbriata* Welw. (1)
*laciniata* Wulf. (1)
*Lactuca* Wulf. (1)
*lapathifolia* Aresch. (1)
*latissima* J. Ag. (10)
*latissima* Linn. ex parte, nec Grev. (1)
*latissima* var. *palmata* Ag. (1)
*latissima* var. *umbilicalis* Ag. (1)
*myriotrema* Crouan (1), (10)
*Ulva reticulata* Salzm. et auct. nonnull., non Forsk. (1)
*rigida* Ag. (1), (10)
*rigida* var. Welw. (1)
*Phycoseris australis* Kuetz. (1)
*lacinulata* Kuetz. (1)
*lapathifolia* Kuetz. ? (1)
*Linza* Kuetz. (1)
*myriotrema* Lenorm. (1)
*rigida* Kuetz. (1)

9. Bryopsis plumosa (Huds.) Ag.

*Bryopsis abietina* Kuetz. (1)
*Arbuscula* Lamour. (1)
*Lyngbyei* Horn. (1)
*Lyngbyei* Fl. Dan. (3)
*Ulva plumosa* Huds. (1), (3), (11)
Varieties include:
*Bryopsis plumosa* Grev. (1)

10. Vaucheria dichotoma (Linn.) Ag.

*Vaucheria globifera* De-Bary (1)
*piriformis* Kuetz. (1)
*salina* Kuetz. (1)
*Conferva dichotoma* Dillw. (1)
*dichotoma* Linn. (1)
*Plinii Setis porcinis* Ray (1)
Varieties include:
*Vaucheria bursata* var. *marina* Kuetz. (1)
*Pilus* Martens (1)
*submarina* Berk. (1), (3)

11. Codium adhaerens (Cabr.) Ag.

*Codium arabicum* Kuetz. (1)
*difforme* Kuetz. (1)
*Agardhia adhaerens* Cabr. (1), (3)
*Spongodium adhaerens* Lenorm. (1)
*cristatum* Bory (1)

14. Codium decorticatum (Woodw.) Howe.

*Codium elongatum* Ag. (9)
*Ulva decorticata* Woodw. (11)

15. Codium Muelleri Kuetz.

*Codium tomentosum* var. *australasicum* Aresch. ex parte (1)

16. Codium fragile (Suring.) Heriot.

*Codium mucronatum* J. Ag. (9), (11)
*tomentosum* Tilden (not Stackh.) (11)
*Acanthocodium fragile* Suring. (1), (11)

17. Caulerpa hypnoides (R.Br.) Ag.

*Caulerpa flexilis* Lamour. (7), (9)
*flexilis* J. Ag. (7)
*Muelleri* Sond. (7) (9)
*Turneri* Lamour. (1), (7)
*Fucus hypnoides* R.Br. (1), (2), (7)
*Chauvinia flexilis* Kuetz. (7)
*hypnoides* Kuetz. (1), (2), (7)

18. Caulerpa scalpelliformis (R.Br.) Ag.

*Caulerpa denticulata* Decne. (7)
*Fucus scalpelliformis* R.Br. (1), (2), (7)

* De Toni regard this as a synonym of *U. Lactuca* Linn. This authority has been followed.

19. Caulerpa sedoides (R.Br.) Ag.

*Caulerpa lactevirens* J. Ag. (not Mont.) (8)
*Fucus sedoides* R.Br. (1), (2), (7), (12)
*Chauvinia sedoides* Kuetz. (1), (2), (7)
*Ahnfeldtia sedoides* Trev. (2)
Varieties include:
*Caulerpa geminata* Harv. (2)

20. Caulerpa articulata Harv.

*Caulerpa Hodkinsonia* J. Ag. (7)

21. Caulerpa cactoides (Turn.) Ag.

*Caulerpa coryncphora* Mont. (12), (2)
*Fucus cactoides* Turn. (1), (2), (7)
*Chauvinia cactoides* Kuetz. (1), (2), (7)
*Trieladia australis* Decne. (1), (7)
*Ahnfeldtia cactoides* Trev. (2)
*corynephora* Trev. (2)

23. Caulerpa flagelliformis Ag.

*Caulerpa filiformis* Hering. (1), (7)
*ligulata* Harv. in J. Ag. (7)
*Phyllerpa flagelliformis* Kuetz. (1), (7)
*Amphibolis filiformis* Suhr. (1), (7)

24. Acetabularia peniculus R.Br.

*Polyphysa aspergillosa* Lamour. (1), (2), (5)
*australis* Lamarck. (1), (2)
*Fucus Peniculus* R.Br. (1), (2), (5)
Varieties include:
*Polyphysa Cliftoni* Harv. (5)

25. Acetabularia crenulata Lamour.

**Acetabularia caraibica* Kuetz. (12)
*integra* var. *minor* Froelich. (12)
* *major* Mart. Preuss. (12)
*Tubularia Acetabulum* var. B. Gmel. (1)

26. Acetabularia Calyculus Quoy & Gaimard.

*Cliftonella Calyculus* J. E. Gray (2)

27. Microdictyon Agardhianum Decne.

*Microdictyon tenue* J. E. Gray (6)
*tenuius* J. E. Gray (6)
† *umbilicatum* (Velley) Zan. (1)
† *Vellcyanum* Decne. (1), (2)
†*Conferva umbilicata* Velley (1), (2)
†*Hydrodictyon umbilicatum* Ag. (1), (2)

28. Microdictyon umbilicatum (Velley) Zan.

† *Microdictyon Agardhianum* Decne. (1), (4)
*tenuis* var. *australis* J. Ag. in part (6)
*Vellcyanum* Decne. in part (1), (6)
*Conferva umbilicata* Velley (1), (6)
*Hydrodictyon umbilicatum* Ag. in part (1), (6)

29. Chaetomorpha aerea (Dillw.) Kuetz.

*Chaetomorpha baltica* Kuetz. (10)
*Dubyana* Kuetz. (1)
*Chaetomorpha gallica* Kuetz. (1)
*herbacea* Kuetz. (1)
*intermedia* in Erb. (1)
*princeps* Kuetz. (1)
*urbica* Kuetz. (1)
*variabilis* Kuetz. (1)
*vasta* Kuetz. (1)
*Diplonema intermedium* De-Not. (1)
*spectabile* De-Not. (1)
*Conferva aerea* Dillw. (1), (10), (11)
*antennina* Bory (3)
*Dubyana* Kuetz. (1)
*princeps* Kuetz. (1)
*urbica* Zan. (1)
*variabilis* Kuetz. (1)
*vasta* Kuetz. (1)

30. Rhizoclonium implexum Batt.

*Rhizoclonium implexum* Kuetz. (1)
*rigidum* Gobi. (10)
*tortuosum* Kuetz. (10)
*Conferva implexa* Harv. (1)
*implexa* Dillw. (10)
*intricata* Grev. (1)
*tortuosa* Dillw. (11)
*Bangia Johnstonii* Grev. (1)
*Chaetomorpha tortuosa* Kuetz. (11)

31. Cladophora rupestris (Linn.) Kuetz.

*Cladophora Lyngbyeana* Phyc. germ. (1)
*Conferva glauca* Roth. (1), (3)
*rupestris* Linn. (1), (3)
*virgata* Roth. (1), (3)
*Ceramium rupestre* DC. (1)
Varieties include:
*Cladophora nuda* Harv. (10)

32. Cladophora fracta (Dillw.) Kuetz.

*Conferva divaricata* Roth. (3)
*flavescens* Wyatt (3)
*fracta* Fl. Dan. (3)
*hirta* Fl. Dan. (3)
*vagabunda* Huds. (3)
Varieties include:
*Cladophora crispata* Hassall (1)
*flavescens* Harv., non Kuetz. (10)
*flexuosa* Batt. (10)
*gossypina* Kuetz. (1)
*heterocladia* Kuetz. (1)
*rigidula* Kuetz. (1)
*strepens* Kuetz. (1)
*viadrina* Kuetz. (1)
*Conferva angulosa* Pollini sec Kuetz. ? (1)
*capillaris* Mont. (1)
*fracta* Dillw. (1)
*fracta* α *patens* Kuetz. (1)
*gossypina* Drap. (1)
*heterocladia* Kuetz. (1)
*pilosa* Aresch. (1)
*ramosa* Beggiat (1)
*strepens* Ag. (1)

* This synonymy is no longer accepted, following Solms-Laubach (1895).
† This synonymy is no longer accepted, following Setchell (1929).

An alphabetical list of the synonyms attributed to the whole, or to part of, species mentioned in the key, has been prepared. Opposite each name is the number of the accepted species as listed in the key, e.g., *Acanthocodium fragile* Suring .. 16 indicates *Codium fragile* (Suring.) Heriot.

*Acanthocodium fragile* Suring. 16
*Acetabularia integra* var. *minor* Froelich. .. .. 25
*Agardhia adhaerens* Cabr. .. 11
*Ahnfeldtia cactoides* Trev. .. 21
*corynephora* Trev. .. .. 21
*sedoides* Trev. .. .. .. 19
*Amphibolis filiformis* Suhr. 23
*Bangia Johnstonii* Grev. .. 30
*Bryopsis abietina* Kuetz. .. 9
*Arbuscula* Lamour. .. .. 9
*Lyngbyei* Horn. .. .. 9
*Lyngbyei* Fl. Dan. .. .. 9
*plumosa* Grev. .. .. .. 9
*Caulerpa corynephora* Mont.? 21
*denticulata* Decne. .. .. 18
*filiformis* Hering. .. .. 23
*flexilis* Lamour. .. .. .. 17
*flexilis* J. Ag. .. .. .. 17
*geminata* Harv. .. .. 19
*Hodkinsonia* J. Ag. .. .. 20
*laetevirens* J. Ag. (not Mont.) .. .. .. .. 19
*ligulata* Harv. in J. Ag. .. 23
*Muelleri* Sond. .. .. .. 17
*Turneri* Lamour. .. .. 17
*Ceramium rupestre* DC. .. 31
*Chaetomorpha baltica* Kuetz. 29
*Dubyana* Kuetz. .. .. 29
*gallica* Kuetz. .. .. .. 29
*herbacea* Kuetz. .. .. 29
*intermedia* in Erb. .. .. 29
*princeps* Kuetz. .. .. .. 29
*tortuosa* Kuetz. .. .. .. 30
*urbica* Kuetz. .. .. .. 29
*variabilis* Kuetz. .. .. 29
*vasta* Kuetz. .. .. .. 29
*Chauvinia cactoides* Kuetz... 21
*flexilis* Kuetz. .. .. .. 17
*hypnoides* Kuetz. .. .. 17
*sedoides* Kuetz. .. .. .. 19
*Cladophora crispata* Hassall 32
*flavescens* Harv. non Kuetz. 32
*flexuosa* Batt. .. .. .. 32
*gossypina* Kuetz. .. .. 32
*heterocladia* Kuetz. .. .. 32
*Lyngbyeana* Phyc. germ. 31
*nuda* Harv. .. .. .. 31
*rigidula* Kuetz. .. .. .. 32
*strepens* Kuetz. .. .. .. 32
*viadrina* Kuetz. .. .. .. 32
*Cliftonella Calyculus* J. E. Gray .. .. .. .. 26
*Codium arabicum* Kuetz. .. 11
*difforme* Kuetz. .. .. .. 11
*elongatum* Ag. .. .. .. 14
*mucronatum* J. Ag. .. .. 16
*tomentosum* var. *australisicum* Aresch. ex parte .. 15
*Codium tomentosum* Tilden (not Stackh.) .. .. 16
*Conferva aerea* Dillw. .. .. 29
*angulosa* Pollini sec Kuetz.? 32
*antennina* Bory .. .. .. 29
*capillaris* Mont. .. .. .. 32
*compressa* Roth. excl. var. 3
*dichotoma* Dillw. .. .. 10
*dichotoma* Linn. .. .. 10
*divaricata* Roth. .. .. 32
*Dubyana* Kuetz. .. .. 29
*flavescens* Wyatt .. .. 32
*fracta* Fl. Dan. .. .. .. 32
*fracta* Dillw. .. .. .. 32
*fracta a patens* Kuetz. .. 32
*glauca* Roth. .. .. .. 31
*gossypina* Drap. .. .. 32
*heterocladia* Kuetz. .. .. 32
*hirta* Fl. Dan. .. .. .. 32
*implexa* Harv. .. .. .. 30
*implexa* Dillw. .. .. .. 30
*intestinalis* Roth. .. .. 1
*intricata* Grev. .. .. .. 30
*pilosa* Aresch. .. .. .. 32
*Plinii Setis porcinis* Ray.. 10
*princeps* Kuetz. .. .. .. 29
*ramosa* Beggiat .. .. .. 32
*rupestris* Linn. .. .. .. 31
*strepens* Ag. .. .. .. 32
*tortuosa* Dillw. .. .. .. 30
*umbilicata* Velley .. .. 28
*urbica* Zan. .. .. .. 29
*vagabunda* Huds. .. .. 32
*variabilis* Kuetz. .. .. 29
*vasta* Kuetz. .. .. .. 29
*virgata* Roth. .. .. .. 31
*Diplomena intermedium* De-Not. .. .. .. .. .. 29
*spectabile* De-Not. .. .. 29
*Enteromorpha acanthophora* Kuetz. .. .. .. .. 3
*africana* Kuetz. .. .. .. 1
*Bertolonii* Mont. .. .. 5
*complanata* Kuetz. .. .. 3
*compressa* Link. .. .. 3
*compressa* Aresch. .. .. 3
*compressa* Crouan .. .. 3
*compressa* var. *lingulata* (J. Ag.) Hauck. .. .. 2
*compressa* var. *prolifera* Grev. .. .. .. .. 4
*crinita* Kuetz.? nec alior.. 2
*fascia* Postels & Ruprecht 3
*fulvescens* Kuetz. .. .. 3
*intestinalis* f. *prolifera* Hauck. .. .. .. .. 4
*lacustris* Hassall .. .. 1
*Linza* (Linn.) J. Ag. .. 5
*minima* Kuetz. .. .. .. 1
*Enteromorpha Novae-Hollandiae* Kuetz. .. .. .. .. 3
*paradoxa* Kuetz. .. .. 3
*pilifera* Kuetz. .. .. .. 4
*prolifera* S. & G. (part).. 3
*ramulosa* Kuetz. .. .. 3
*spermatoidea* Kuetz... .. 1
*spinescens* Kuetz. .. .. 3
*tubulosa* var. *pilifera* Ahln. 4
*Fistularia compressa* Grev... 3
*intestinalis* Grev. .. .. 1
*Fucus cactoides* Turn. .. .. 21
*hypnoides* R. Br. .. .. 17
*Penicillus* R. Br. .. .. 24
*scalpelliformis* R. Br. .. 18
*sedoides* R. Br. .. .. .. 19
*Hydrodictyon umbilicatum* Ag. (part) .. .. .. 28
*Ilea Bertolonii* De-Not. .. 5
*compressa* Gaill. .. .. 3
*intestinalis* Gaill. .. .. 1
*Microdictyon tenue* J. E. Gray .. .. .. .. 27
*tenuis* var. *australis* J. Ag. in part .. .. .. .. 28
*tenuius* J. E. Gray .. .. 27
*Velleyanum* Decne. (part) 28
*Phycoseris australis* Kuetz. 7
*crispata* Kuetz. .. .. .. 5
*lacinulata* Kuetz. .. .. 7
*lanceolata* Kuetz. .. .. 5
*lapathifolia* Kuetz.? .. .. 7
*Linza* Kuetz. .. .. .. 7
*myriotrema* Lenorm. .. 7
*olivacea* Kuetz. .. .. .. 5
*planifolia* Kuetz. .. .. 5
*rigida* Kuetz. .. .. .. 7
*smaragdina* Kuetz. .. .. 5
*Phyllerpa flagelliformis* Kuetz. 23
*Polyphysa aspergillosa* Lamour. .. .. .. .. 24
*australis* Lamarck .. .. 24
*Cliftoni* Harv. .. .. .. 24
*Rhizoclonium implexum* Kuetz. .. .. .. .. 30
*rigidum* Gobi. .. .. .. 30
*tortuosum* Kuetz. .. .. 30
*Scytosiphon compressus* Lyngb. A partim .. .. 3
*compressus* var. *crispatus* Lyngb. .. .. .. .. 4
*intestinalis* Lyngb. .. .. 1
*intestinalis* var. *Cornucopiae* Lyngb. .. .. .. 1
*Solenia Bertolonii* Ag. .. .. 5
*compressa* Ag. .. .. .. 3
*intestinalis* Ag. .. .. .. 1
*Spongodium adhaerens* Lenorm. .. .. .. .. 11

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